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TRANSMITTAL OF APPEAL BRIEF (Large Entity)	Docket No. APP 1434

In Re Application Of: **John T. Peoples**

Application No.	Filing Date	Examiner	Customer No.	Group Art Unit	Confirmation No.
10/061,815	**02/01/2002**	**TRAN, QUOC DUC**	**09941**	**2643**	**1892**

Invention: **Determining the Composition of Subscriber Loop from Frequency Domain Measurements**

COMMISSIONER FOR PATENTS:

Transmitted herewith in triplicate is the Appeal Brief in this application, with respect to the Notice of Appeal filed on

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William A. Schoneman
Signature

Dated: 1/10/2005

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Attorney Docket APP 1434-US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

John T. Peoples
Application No. 10/061,815
Filed: February 1, 2002
Art Unit: 2643
Examiner: Quoc Duc Tran

Title: Determining The Composition Of Subscriber Loops From Frequency Domain Measurements

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BRIEF ON APPEAL BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

This appeal arises from the Examiner's Final Rejection dated May 11, 2004, of claims 1-6 and 8-20.

(i) Real Party in Interest

The real party in interest is Telcordia Technologies, Inc., the assignee of the invention according to an assignment dated September 19, 2001 and recorded at reel no. 012037, frame no. 0812.

(ii) Related Appeals and Interferences

To the best of knowledge of the legal representative of assignee, Telcordia Technologies, Inc., there are no other appeals or interferences which will directly affect or be directly affected or have a bearing on the Board's decision in the pending appeal.

(iii) Status of Claims

In the present Application Serial No. 10/061,815 claims 1-5 and 8-10 are now as they were originally presented. Claim 6 was amended by an Amendment dated March 5, 2004 at which time claim 7 was cancelled.

In the Office Action dated November 6, 2004, claims 1-20 were rejected by the Examiner. Claims 1, 2, 4-8, 10-17, 19 and 20 were rejected as being anticipated by United States Patent No. 6,466,649 to Walance et al. Claims 3, 9 and 18 were rejected as being

obvious in view of the Walance further in view of United States Patent No. 5,949,236 to Franchville.

By an Amendment dated March 5, 2004, claim 6 was amended into its current form and claim 7 was cancelled. The subject matter of claim 7 was added into claim 6.

In a Final Office Action of May 11, 2004 rejecting pending claims 1-6 and 8-20, the Examiner repeated the same words of rejection as in the prior Office Action but adding a section in response to the arguments present by the appellant.

The appellant filed an Amendment dated July 6, 2004 setting forth additional arguments distinguishing the claims from the primary (Walance et al.) and secondary (Frenchville) references cited by the Examiner.

On September 9, 2004 the Examiner issued an Advisory Action stating that the additional arguments presented did not persuade the Examiner to allow any of the claims presented.

The Examiner and the appellant have a fundamental disagreement over the applicability of Walance et al. and Frenchville references to the claims at issue.

(iv) Status of Amendment

No amendments have been made or presented with respect to claims 1-6 and 8-20 after final rejection. Only claim 6 has been amended from the originally presented claims.

(v) Summary of Claimed Subject Matter

The present invention is a method for determining the composition of a subscriber loop in a telecommunications system by using improved signal processing techniques that can refine the resolution of the swept-frequency measurements so as to further identify previously-masked peaks in the power spectrum. One technique for determining loop composition is based on an analysis of frequency domain loop response using a transform algorithm such as a Fast Fourier Transform algorithm (Specification, p. 10, line 1 to p. 12, line 9). The prior method of using a rectangular weight window to generate a transform domain or spectral domain plot of loop response in a loop having one or more changes in the gauge of the wire comprising the loop results in a plot that severely masks peaks due to gauge transitions. (Specification, p. 12, line 11 to p. 14, line 5).

The present invention uses a prolate spheroidal wave function to improve the determination of the composition of subscriber loops, particularly those containing gauge changes. (Specification, p. 15, line 7 to p. 18, line 25). A method for estimating distances to irregularities on a subscriber loop measures loop response as a function of frequency at a loop end (Specification, p. 10, line 12 to p. 11, line 20; p. 12, line 12 to p. 13, line 12; p. 22, lines 16-17; and Fig. 13), weights the loop response with a pre-selected prolate spheroidal wave function (pswf) to produce a weighted response (Specification, p. 14, line 10 to p. 15, line 11; p. 17, line 18 to p. 18, line 4; and p. 22, lines 18-19) and generates a spectral analysis of the weighted response wherein the estimated distances to the irregularities correspond to peaks in the spectral analysis (Specification, p. 17, line 18 to p. 18, line 4 and p. 22, lines 19-20). In another novel aspect, the weighted loop response (such as a pswf weighted loop response) may be iteratively multiplied with a pre-

determined multiplier function to produce a characteristic function (Specification, p. 15, line 13 to p. 18, line 11 and p. 22, lines 19-21) which are then transformed iteratively to produce a characteristic function to determine a set of corresponding characteristic values (Specification, p. 18, line 12 to p. 20, line 3 and p. 22, lines 22-24). From this the local maxima from the set of characteristic values provides an estimate to the distances to each of the irregularities (Specification, p. 20, line 4 to p. 21, line 20 and p. 22, line 24 to p. 23, line 5). A hypothesized set of possible solutions can be constructed from which the closest solution can be chosen based on a similarity measure (Specification, p. 18, line 12 to p. 22, line 5 and p. 22, line 23 to p. 23, line 5).

(vi) Grounds of Rejection to be Reviewed on Appeal

In the Final Office Action dated May 11, 2004, claims 1, 2, 4-6, 8 10-17, 19 and 20 were rejected as being anticipated by United States Patent No. 6,466,649 to Walance et al. ("6,466,649"). In that Office Action the Examiner stated that as to claim 1 "Walance [sic] et al teach a method for estimating distances to irregularities on a subscriber loop (col. 1 lines 6-10) comprising the steps of measuring a loop response as a function of frequency at a loop end, weighting the loop response with a pre-selected prolate spheroidal wave function to produce a weighted response, and generating a spectral analysis of the weighted response wherein the estimated distances to the irregularities correspond to peaks in the spectral analysis (col. 1 lines 60-67; col. 2 lines 5-31)". The Examiner stated that the subject matter of claim 2 could be found at col. 2, lines 32-43 of Walance; the subject matter of claim 4 at col. 2, lines 14-43, col 2, line 64 to col. 3, line 8 and col. 5, line 24 to col. 6, line 22 and the subject matter of claim 5 in Fig. 4 of Walance.

With regard to claim 6, the Examiner states that "Walance [sic] et al teach a method for estimating distances to irregularities on a subscriber loop (col. 1, lines 6-10) comprising the steps of measuring the real part of the return loss of the loop using a pre-selected reference impedance over a band of frequencies to generate a loop response (col. 2 lines 15-43; col. 2 line 54 – col. 3 line8; col.5 line 24 – col. 6 line22), weighting the loop response with a *pre-selected prolate spheroidal wave function* to generate a weighted loop response, iteratively multiplying the weighted loop response with a pre-determined multiplier function to produce a characteristic function, transforming each iteratively produced characteristic function to determine a set of corresponding characteristic values, and selecting local maxima from the set of characteristic values as estimated to the distances to the irregularities (col. 1, lines 60-67; col. 2 lines 5-31; col. 3 lines 10-49)" (emphasis in the original). The Examiner states that the subject matter of dependent claim 8 could be found at col. 2 lines 32-43 of Walance, the subject matter of dependent claim 10 at Fig 4, col. 3 lines 37-49 and col. 7, line 49 – col. 8, line 27), the subject matter of dependent claim 11 at Fig. 4; col. 3 lines 37-49 and col. 7, line 49 – col. 8, line 27), and the subject matter of independent claim 12 at col. 3, lines 10-49).

The rejection of claims 13-14 and 15-17, 19 and 20 are similar with the Examiner pointing to col. 2 lines 10-31 as disclosing the step of weighting the loop response with a prolate spheroidal wave function waveform. With respect to independent claim 13, the Examiner found the steps of hypothesizing a set of loops having irregularities commensurate with the estimated distances to the irregularities and selecting one of the loops by comparing the measured loop response to a corresponding loop response from the selected one of the loops to be disclosed in the Walance reference at col. 1 lines 60-67, col. 2 lines 5-31 and col. 3 lines 10-49). Likewise the Examiner found the steps of independent claim 15 including the step of transforming each iteratively produced

characteristic function to determine a ser of corresponding characteristic values in the same places in the Walance reference.

Claims 3, 9 and 18 were rejected by the Examiner as being unpatentable under 35 U.S.C. § 103(a) as being unpatentable over Walance in view of United States Patent No. 5,949,236 to Franchville ("Franchville"). With regard to claims 3, 9 and 18 the Examiner used Frenchville to overcome a deficiency in Walance with regard to Fast Fourier Transforms.

The issues presented by this appeal are:

(a) whether the Walance reference anticipates claims 1-2, 4-5, 14 and 16 by disclosing a method for estimating distances to irregularities on a subscriber loop that measures loop response as a function of frequency at a loop end and weights the loop response with a pre-selected prolate spheroidal wave function (pswf) to produce a weighted response to generate a spectral analysis of the weighted response wherein the estimated distances to the irregularities correspond to peaks in the spectral analysis.

(b) whether the Walance reference anticipates claims 6 and 8-12 by disclosing a method for estimating distances to irregularities on a subscriber loop that measures loop response as a function of frequency at a loop end, weights the loop response with a pre-selected prolate spheroidal wave function (pswf) to produce a weighted response, iteratively multiplies the weighted loop response with a pre-determined multiplier function to produce a characteristic function, transforms each iteratively produced characteristic function to determine a set of corresponding characteristic values and estimates distances to the irregularities by selecting local maxima from the set of characteristic values.

(c) whether the Walance reference anticipates claim 13 by disclosing a method for estimating distances to irregularities on a subscriber loop having the steps of hypothesizing a set of loops having irregularities commensurate with the estimated distances to the irregularities and selecting one of the loops from the set by comparing the measured loop response to a corresponding loop response from the selected one of the loops.

(d) whether the Walance reference anticipates claims 15, 17 and 19-20 by disclosing a method for estimating distances to irregularities on a subscriber loop having the combination of steps of iteratively multiplying the weighted loop response to produce a characteristic function; transforming each iteratively produced characteristic function to determine a set of corresponding characteristic values; hypothesizing a set of loops wherein each of the loops in the set has a set of characteristic values commensurate with the set of characteristic values of the measured loop and selecting one of the loops form the set of loops based upon a comparison of each set of characteristic values of each of the loops to the set of characteristic values of the measured loop.

(e) whether the combination of Walance and Frenchville would make claims 3, 9 and 18 obvious to one skilled in the art.

(vii) Argument

Claims 1, 2, 4-6, 8, 10-17, 19 and 20 are rejected as being anticipated by Walance. However, various claim groups contain different combinations of novel steps.

Claims 1-5, 14 and 16 should stand and fall together as relating to a combination of steps including the novel step of weighting the loop response with a pre-selected prolate spheroidal wave function to produce a weighted response.

Claims 6 and 8-12 should stand and fall together as relating to the combination of novel steps of weighting the loop response with a pre-selected prolate spheroidal wave function, iteratively multiplying the weighted loop response with a pre-determined multiplier function to produce a characteristic function and transforming each iteratively produced characteristic function to determine a set of corresponding characteristic values.

Claim 13 should stand and fall on its own as relating to the novel steps of hypothesizing a set of loops having irregularities commensurate with the estimated distances to the irregularities and selecting one of the loops from the set by comparing the measured loop response to a corresponding loop response from the selected one of the loops.

Claims 15, 17-20 should stand and fall on their own as relating to a different combination of the novel steps including the novel steps of iteratively multiplying the weighted loop response to produce a characteristic function; transforming each iteratively produced characteristic function to determine a set of corresponding characteristic values; hypothesizing a set of loops wherein each of the loops in the set has a set of characteristic values commensurate with the set of characteristic values of the measured loop and selecting one of the loops form the set of loops based upon a comparison of each set of characteristic values of each of the loops to the set of characteristic values of the measured loop.

I. The Examiner erred in rejecting claims 1-2, 4, 14 and 16 and claims 6 and 8-11 under 35 U.S.C. § 102 as being anticipated by Walance by failing to appreciate the novelty of application of the prolate spheroidal wave function to the present method. The Examiner states that Walance teaches a method for estimating distances to irregularities on a subscriber loop comprising the steps of measuring a loop response as a function of frequency at a loop end, weighting the loop response with a pre-selected prolate spheroidal wave function to produce a weighted response and generating a spectral analysis of the weighted response wherein the estimated distances to the irregularities correspond to peaks in the spectral analysis. The Examiner cites column 1, lines 6-10, column 1, lines 60-67 and column 2, lines 5-31 as being the location in Walance that describes these claimed steps of independent claim 1. Appellant respectfully disagrees that Walance teaches the step of "weighting the loop response with a pre-selected prolate spheroidal wave function to produce a weighted response." At column 2, line 11, Walance states that the "response data is weighted to optimize the accuracy of the analysis." Walance does not, however, teach or suggest the use of a pre-selected prolate spheroidal wave function for such weighting. Claims 1-2, 4, 14 and 16 and claims 6 and 8-11 are neither taught nor suggested by Walance for this reason.

The advantageous characteristics of the <u>prolate spheroidal wave function</u> (pswf) recited by the appellant have not been fully comprehended by the Examiner. The particular pswf disclosed and claimed by the appellant is the only mathematical function that has essentially finite support in both its domain of definition and the transform of this domain. For example, as used in the specification, if the domain of definition is the

frequency domain, then the transformed domain is taken as the time domain. For instance, it can be seen from FIG. 5A that the domain of definition of the pswf encompasses 1000 abscissa points. From FIG. 5B, it can be seen that support of the transform of the pswf depicted in FIG. 5A is limited to, on a normalized basis, values between 0 and approximately 0.14. No other weight function, including rectangular, Hamming, Hanning, etc., has the desirable property of finite range of support in both domains. Because of this property, it is now possible to preclude interactions between and among frequency components in a waveform that are spaced sufficiently far apart. For instance, if a waveform is composed of two sinusoids of frequency f_1 and f_2, and the waveform is weighted by the pswf, then in the transform domain, the frequencies f_1 and f_2 can be individually identified if there is sufficient separation between the two frequencies. Moreover, it is guaranteed that there is no interaction between the two frequencies because of the pswf weighting; no other weighting window provides this guarantee.

FIGS. 8A and 8B depict this property of the pswf. FIG. 8A shows that rectangular weighting masks the peak at about 175 on the normalized scale; the same would basically be true for the Hanning, Hamming, etc. windows. On the other hand, FIG. 8B depicts that, because the interaction between the two frequency components is eliminated by pswf weighting, the two frequency components are clearly identifiable.

Accordingly, the Examiner's reasoning that both Walance and the appellant use a similar approach for weighting of the response and, consequently, Walance "reads on the applicant limitation as claimed" is clearly erroneous. The appellant acknowledges that it is well-known to weight a waveform of limited duration (say in the frequency domain as is the present case) so as to "avoid spurious results" in the transform domain as stated by Walance; however, that is all that Walance teaches or suggests. The appellant strongly contends that the use of a prolate spheroidal wave function for weighing is neither taught nor suggested by Walance. Claims 1-2, 4, 14 and 16 and claims 6 and 8-11 are neither taught nor suggested by Walance for this reason.

II. The Examiner erred in rejecting claims 6-8 and 11 and claims 15 and 17-20 as being anticipated by Walance by failing to appreciate the novel aspect of these claims relating to the "characteristic function". The use of the characteristic function recited by the appellant was not fully appreciated by the Examiner. The use of the characteristic function builds upon the principles elucidated in the foregoing paragraphs in which it is stated that "..., if a waveform is composed of two sinusoids of frequency f_1 and f_2, and the waveform is weighted by the pswf, then in the transform domain, the frequencies f_1 and f_2 can be individually identified if there is sufficient separation between the two frequencies. Moreover, it is guaranteed that there is no interaction between the two frequencies because of the pswf weighting; no other weighting window provides this guarantee."

The purpose of the characteristic function is to actually induce sufficient separation between and among frequency components. Again with reference to appellant's FIG. 8B and the discussion of this figure, it is seen that there are two peaks in the transform of the weighted response, namely, a peak at roughly 175 and another peak at roughly 280 on the normalized scale. The first peak is separated from the second peak by 105 normalized units, or in terms of percentages, the second peak is within 60% of the first peak. Now conjecture it is possible to "slide" the peak at 175 to 10 on the normalized scale and,

correspondingly, the peak at 280 slides to 115 on the normalized scale. Then the first peak is still separated from the second peak by 105 units, but in terms of percentage, the separation between the peaks increases to 1050%. If the first peak slides to 1 unit, the percentage separation becomes 10500%. In the limit, as the first peak slides towards 0 on the normalized scale, the percentage separation approaches infinity.

From the viewpoint of detecting each peak as it is shifted to 0, it is extremely simple to build a "low-pass" filter centered about 0 on the normalized scale in order to isolate the peak at 0 from "nearby" peaks; that is, whereas the location of peaks before shifting may be "close", after shifting, the peaks are sufficiently separated to effect easy detection. On the other hand, it is much more complicated to build a "band-pass" filter so as to distinguish the peak at 170 from the peak at 280. As the peaks approach one another, the "band-pass" filter becomes virtually impossible to design. Thus the key to processing the loop response is to slide each peak to 0 on the normalized scale to accurately identify the actual location of each peak on the normalized scale.

To see how dramatically the use of the characteristic function improves the resolution of peaks, reference is first made to appellant's FIG. 10. Because of the loop structure, it is expected that there should be three primary peaks and possibly secondary peaks due to multiple reflections from the loop discontinuities. It is virtually impossible to discern any more than two peaks from FIG. 10. On the other hand with reference to FIG. 11, if the loop response is iteratively shifted and the multiplicity of peaks at 0 on the normalized scale are noted as the iteration process unfolds, then it is possible to discern the primary as well as secondary peaks.

To generate the characteristic function, consider the following summary of details disclosed in the appellant's specification. First, note the following well-known relation: cos(A)cos(B) = [cos(A-B) + cos(A+B)] / 2 (equation 4 of the specification), where A and B are arbitrary. Whenever A=B, then this equation becomes
cos(A)cos(A) = [1 + cos(2A)] / 2. Upon the transformation of this latter equation, there is a peak at the 0 abscissa value from the (1/2) term, and another peak at the abscissa corresponding to the term [cos(2A)] / 2.

Next, apply this principle to the loop response by multiplying equation (3) of the specification by $cos\,(2\beta_C L_C)$ where β_C is presumed known (e.g., β for 26-gauge cable, or 24-gauge cable, or an average over the known cable gauges) and L_C is a selected length. This leads to, ignoring the multiple reflection terms for the moment:

$$[\sum_{i=1}^{N} A_i(\omega)exp(-2\alpha_i L_i)cos(2\beta_i L_i)]\ cos\,(2\beta_C L_C). \qquad (6)$$

If $\beta_C = \beta i$, and focusing on the cosine terms only of equation (6) as follows:

$$cos\,(2\beta_i L_i)cos\,(2\beta_C L_C) = [cos(2\beta_C(L_i - L_C)) + cos(2\beta_C(L_i + L_C))] / 2\,. \qquad (7)$$

Equation (7) is the characteristic function for a given L_C.

If L_C is <u>iteratively</u> varied over a range (say over the length of the loop or more typically over an intermediate length encompassing the irregularities), then at values of L_C equal to the L_i's, the right-hand side of equation (7) becomes

$$[1 + cos\,(4\beta_C L_C)]\ /2. \qquad (8)$$

Thus, peaks in the spectral domain at each L_i can be shifted to the 0-abscissa value by the proper choice of L_C. <u>The term at the 0-abscissa is called the characteristic value</u>. If each

characteristic value is determined for each of the iteratively selected values of L_C, and all the characteristic values form a set, then the peaks in this set of characteristic values estimate the $L_i's$.

From this process, it is clear that Walance is distinguishable. Walance merely teaches or suggests that the weighted line response is multiplied, only once, by a loss compensation function. The loss compensation function is introduced to enhance the amplitude of the line response since the amplitude of the line response is known to decay exponentially (see equation (6) above). The appellant, on the other hand, totally ignores the amplitude of the loop response and focuses only on the zero-crossings or frequencies of the loop response. Frequency shifting is accomplished by introducing a multiplicative factor, namely, a cosine function. Moreover, this multiplicative factor is iterated over a frequency range that includes the anticipated peaks in the transformed, weighted loop response. This aspect of the disclosure has been referred to as "distance filtering", meaning that it now becomes possible to focus on the subset of distances to discontinuities that cause the frequency peaks. For this reason, claims 6-8 and 11 and claims 15 and 17-20 should be allowable.

III. The Examiner erred in rejecting claim 13 and claims 15 and 17-20 as being anticipated by Walance by failing to appreciate the novel aspect of these claims relating to the hypothesized loop aspect of the present invention. The appellant's inventive subject matter relates to determining the composition of a loop. Accordingly, once the set of peaks in the characteristic values has been determined with sufficient accuracy by mitigating interactions, it now becomes necessary to devise a methodology to make effective use of the set of peaks. The appellant has devised a procedure wherein a set of loops is hypothesized which give rise, presumably, to the same set of characteristic values. The hypothesized set is selected based upon set of peaks in the characteristic values, as exemplified in detail on pages 20 and 21 of the specification. For example, the loop of FIG. 11A exhibits five peaks in the set of characteristic values. It is easily deduced that the first two peaks are due to irregularities, whereas the last three peaks are either due irregularities or multiple reflections. The hypothesized loops mirror these considerations. Then a similarity measure is applied to determine the loop having the closest set of peaks in its characteristic values as compared to the set from the actual loop under test.

Walance speaks of "bins", and the Examiner misstates the Walance "determines the bins of responses on the bases of assumption or hypothesis". In fact, the determination of "bins" bears no relation to assumption or hypothesis, and certainly no relation to hypothesized loop structures. The "bins" are merely labels on the discrete points in the transformed domain. It is well-known that one can process a waveform by sampling said waveform to produce a sampled waveform. Then if a so-called Discrete Fourier Transform (DFT) algorithm is used to transform the sampled waveform (as in Walance), then in the transform domain, there are data points appearing at a finite set of points corresponding to the number of samples in the original waveform -- each of the points in the transformed domain is referred to as a "bin". The Examiner's rationale is untenable.

IV. The Examiner erred in rejecting claims 3, 9 and 18 as being obvious to one skilled in the art and as being obvious in view of Walance and Frenchville. Frenchville does not overcome the deficiencies with the primary reference discussed above and claims 3, 9 and 18 are neither taught nor suggested by Walance, alone or in combination with Frenchville.

Conclusion

Appellant's inventive method contains novel steps in at least thee different areas: (1) the step of weighting the loop response with a pre-selected prolate spheroidal wave function; (2) the steps of iteratively multiplying the weighted loop response with a pre-determined multiplier function to determine a set of corresponding characteristic values and transforming each to determine a set of corresponding characteristic values; and (3) the steps of hypothesizing a set of loops having irregularities commensurate with the estimated distances to the irregularities and selecting one of the loops by comparing the measured loop response to a corresponding loop response from the selected one of the loops. There is no suggestion or teaching in these references of appellant's invention as claimed. The references relied upon simply do not in any way teach or suggest appellant's invention.

For the reasons set forth above, it is submitted that the Final Rejection of claims 1-6 and 8-20 is in error. Reversal of this rejection is therefore respectfully requested.

The Commissioner is authorized to charge Deposit Account Number 021822 to cover the fee for this Appeal Brief.

Respectfully submitted,

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Enclosures:
Two Additional Copies of this Appeal Brief

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Dated: January 10, 2005

(viii) Claims Appendix

CLAIMS ON APPEAL

Claim 1: A method for estimating distances to irregularities on a subscriber loop comprising the steps of

measuring a loop response as a function of frequency at a loop end,

weighting the loop response with a pre-selected prolate spheroidal wave function to produce a weighted response, and

generating a spectral analysis of the weighted response wherein the estimated distances to the irregularities correspond to peaks in the spectral analysis.

Claim 2: The method as recited in claim 1 wherein the step of generating the spectral analysis of the weighted function includes the steps of

transforming the weighted function via a Fourier Transform to produce a transformed function, and

identifying the peaks in the transformed function to obtain the estimated distances.

Claim 3: The method as recited in claim 1 wherein the step of generating the spectral analysis of the weighted function includes the steps of

transforming the weighted function via a Fast Fourier Transform to produce a transformed function, and

identifying the peaks in the transformed function to obtain the estimated distances.

Claim 4: The method as recited in claim 1 wherein the loop response is the real part of the return loss of the loop with respect to a reference impedance and the step of measuring

includes the step of measuring a swept-frequency signal proportional to the real part of the return loss.

Claim 5: The method as recited in claim 1 wherein the loop response is composed of exponentially decaying co-sinusoids and the step of measuring includes the step of measuring a swept-frequency signal proportional to the loop response.

Claim 6: A method for estimating distances to irregularities on a subscriber loop comprising the steps of

measuring the real part of the return loss of the loop using a pre-selected reference impedance over a band of frequencies to generate a loop response,

weighting the loop response with a pre-selected prolate spheroidal wave function to generate a weighted loop response,

iteratively multiplying the weighted loop response with a pre-determined multiplier function to produce a characteristic function,

transforming each iteratively produced characteristic function to determine a set of corresponding characteristic values, and

selecting local maxima from the set of characteristic values as estimates to the distances to the irregularities.

Claim 8: The method as recited in claim 6 wherein the step of transforming includes the step of Fourier Transforming the weighted loop response.

Claim 9: The method as recited in claim 6 wherein the step of transforming includes the step of Fast Fourier Transforming the weighted loop response.

Claim 10: The method as recited in claim 6 wherein the multiplier function is a co-sinusoidal function and the step of iteratively multiplying includes the step of incrementally selecting a new period for the co-sinusoidal function with reference to the length of the loop.

Claim 11: The method as recited in claim 6 wherein the multiplier function is a co-sinusoidal function and the step of iteratively multiplying includes the step of incrementally selecting a new period for the co-sinusoidal function with reference to intermediate distances along the loop.

Claim 12: The method as recited in claim 6 further including the steps, after the step of selecting, of

hypothesizing a set of loops having irregularities commensurate with the estimated distances to the irregularities, and

selecting one of the loops from the set by comparing the measured loop response to a corresponding loop response from the selected one of the loops.

Claim 13: A method for determining a configuration for a subscriber loop comprising the steps of

measuring a loop response as a function of frequency at a loop end,

weighting the loop response with a weight function to produce a weighted response,

generating a spectral analysis of the weighted response wherein the estimated distances to the irregularities correspond to peaks in the spectral analysis,

hypothesizing a set of loops having irregularities commensurate with the estimated distances to the irregularities, and

selecting one of the loops from the set by comparing the measured loop response to a corresponding loop response from the selected one of the loops.

Claim 14: The method as recited in claim 13 wherein the step of weighting includes the step of weighting the loop response with a prolate spheroidal wave function waveform.

Claim 15: A method for determining the configuration of a subscriber loop comprising the steps of

measuring the real part of the return loss of the loop using a pre-selected reference impedance over a band of frequencies to generate a loop response,

weighting the loop response with a spectral window to generate a weighted loop response,

iteratively multiplying the weighted loop response with a pre-determined multiplier function to produce a characteristic function,

transforming each iteratively produced characteristic function to determine a set of corresponding characteristic values,

hypothesizing a set of loops wherein each of the loops in the set has a set of characteristic values commensurate with the set of characteristic values of the measured loop, and

selecting one of the loops from the set of loops based upon a comparison of each set of characteristic values of each of the loops to the set of characteristic values of the measured loop.

Claim 16: The method as recited in claim 15 wherein the step of weighting includes the step of multiplying the loop response by a pre-selected prolate spheroidal wave function to produce the weighted response.

Claim 17: The method as recited in claim 15 wherein the step of transforming includes the step of Fourier Transforming the weighted loop response.

Claim 18: The method as recited in claim 15 wherein the step of transforming includes the step of Fast Fourier Transforming the weighted loop response.

Claim 19: The method as recited in claim 15 wherein the multiplier function is a co-sinusoidal function and the step of iteratively multiplying includes the step of incrementally selecting a new period for the co-sinusoidal function with reference to the length of the loop.

Claim 20: The method as recited in claim 15 wherein the multiplier function is a co-sinusoidal function and the step of iteratively multiplying includes the step of incrementally selecting a new period for the co-sinusoidal function with reference to intermediate distances along the loop.

(ix) Evidence Appendix

None

(x) Related Proceedings Appendix

None